# *Crayfish Investigations*

## Overview

One of the most successful groups of animals in the world are the members of the phylum Arthropoda, which means "jointed legs." There are three times more species of arthropods than all other animal species combined. This group of invertebrates (animals without backbones) includes the insects, spiders, mites, and the crustaceans such as the crayfish, lobster, crab, barnacle, and shrimp. The crustaceans are almost entirely marine (living in salt water), but one of the notable brackish and freshwater exceptions is the incredibly successful crayfish. By observing crayfish that live in wetlands and streams, we can begin to understand how their ocean relatives live as well.

In Crayfish Investigations, students are guided through a full open-ended inquiry in five sessions. (An alternate route provides students with a partial inquiry in three sessions.) In Session 1, students are introduced to the Inquiry Journal and focus on making observations, sketching, and asking questions about crayfish in the I Notice...I Wonder activity.

Session 2 focuses on generating more questions and categorizing them as investigable or not investigable based on the "Class Rules About What We Can Investigate." Students are also provided with more background information about crayfish on which to base their investigations as they discover answers to the "Lookup" questions. This session ends with small groups of students choosing their investigation question, and planning the investigation to answer that question.

In Session 3, students do their crayfish investigation in small groups, again using the Inquiry Journal to organize their record-keeping and guide them through the process. Session 4 provides the opportunity for students to make a presentation poster and participate in Part 1 of a poster session and gallery walk to present their results and hear about their classmates investigations. The second half of the class presents their posters in Session 5, which also provides the opportunity for synthesis of the content and process of the inquiry. Students discover that crayfish have many adaptations to survive and thrive in the wetland habitat. They also discover and practice the process of how scientists learn about the world.

## What You Need

### Session 1:

**For the class:**

- ❑ 5-10 live crayfish (See Getting Ready)
- ❑ 1-2 large aquariums (about 10 - 25 gallons)
- ❑ clean, dechlorinated water to fill aquarium to a level of about 4" (See Getting Ready)
- ❑ 1 small bottle of dechlorinating liquid
- ❑ clean gravel to cover bottom of 10 gal. Aquarium
- ❑ 5-10 pieces broken clay flower pots, large enough for crayfish to hide under
- ❑ 20 Elodea sprigs (See Getting Ready)
- ❑ paper towels
- ❑ flake fish food, tubifex worms, or fresh or frozen fish (See Getting Ready)
- ❑ several small containers or plastic cups
- ❑ several small fish nets
- ❑ 3 sheets of chart paper
- ❑ colored markers (various colors, wide-tipped)
- ❑ overhead projector
- ❑ 5-10 transparencies
- ❑ transparency pens (various colors)
- ❑ masking tape

**For each group of 4-5 students:**

- ❑ 4-5 pencils
- ❑ 4-5 Inquiry Journals (See Getting Ready)
- ❑ 1 clear plastic shoe box or similar aquarium (See Getting Ready)
- ❑ clean, dechlorinated water to fill plastic shoeboxes about 2-3" deep

### Session 2

**For the class:**

- ❑ 2-3 rolls masking tape
- ❑ 3 sheets chart paper
- ❑ colored markers (various colors, wide-tipped)
- ❑ Optional, but highly recommended: Books about crayfish and other crustaceans and arthropods (See Getting Ready)

**For each group of 4 - 5 students:**

- ❑ 10 - 20 sentence strips
- ❑ 4-5 Inquiry Journals from Session 1
- ❑ 4-5 pencils
- ❑ 3-5 Crayfish Information Cards (See Getting Ready)

*Materials for Alternate Session 3 if you don't plan on having students do the full investigation*
***For the class:***
*1 sheet of chart paper*
*colored markers*
*overhead projector*
*transparencies*

***For each student:***
*Inquiry Journal*
*pencil*

## For Session 3:

**For the class:**

- Crayfish and crayfish materials from Session 1
- various other materials as needed for student investigations (See Getting Ready). Some options or possibilities include:
  - 10 or more small aquariums
  - dechlorinating liquid
  - nets
  - aluminum foil
  - 2-3 flashlights
  - small pieces of red cellophane
  - 5-10 sheets black construction paper
  - thermometers
  - small food scale
  - rulers
  - 5 or so feeder goldfish
  - tubifex worms
  - magnifying lenses

**For each small group of 4-5 students:**

- 4-5 Inquiry Journals (from previous sessions)
- 4-5 pencils
- various materials for investigations brought by students from home (See Getting Ready)

## For Session 4:

**For the class**

- masking tape

**For each small group of 4-5 students:**

- 2 sheets chart paper
- colored markers (various colors)
- 4-5 Inquiry Journals (from previous sessions)
- 4-5 pencils

## For Session 5:

**For the class:**

- ❑ 2 sheets of chart paper
- ❑ colored markers (various colors)
- ❑ overhead projector
- ❑ 5-10 transparencies
- ❑ transparency pens (various colors)

**For each small group of 4-5 students:**

- ❑ 4-5 Inquiry Journals (from previous sessions)
- ❑ 4-5 pencils

## Getting Ready

### 1. Ordering Crayfish

Crayfish can be ordered from scientific supply houses such as Carolina Biological (800) 547-1733. Order a few extra crayfish than you think you will need in case some die, are reluctant to move around or have recently molted. When you order them we recommend you try to obtain the red eastern crayfish, which live in still water. These are the easiest to keep alive and don't require refrigeration or an air stone. The western brown crayfish are harder to keep alive, as they live in cold flowing water. To maintain these crayfish, keep them in an aquarium with an air pump (aerator).

You can also collect your own crayfish if there is an appropriate wetland, stream or pond nearby. In some areas crayfish can be bought from bait shops, or even from pet stores which is usually the most expensive option.

Most supply houses also provide several other preserved or live crustaceans for comparison, such as hermit crabs, brine shrimp, barnacles, crabs, etc. or buy a live crab or lobster at a local seafood market.

You can keep crayfish in the refrigerator for up to two days if you wrap them in wet newspaper or pond plants. But you must keep their gills wet, so they can breathe.

### 2. Keeping Crayfish in the Classroom

Crayfish are quite hardy, but there are a few important procedures that should be followed to keep the crayfish healthy and alive.

• First of all, be sure to put dechlorinating drops (follow the package directions) in the fresh, clean water you use and remember to change the water frequently.
• Feed the crayfish in a different aquarium than the one that is their habitat so that the water isn't fouled by old food. The exceptions are living tubifex worms and living feeder fish. You can put living prey directly into the crayfish habitat and they will live there. The crayfish can then eat them as they catch them. Dead food like pieces of fish, catfood, crayfish chow or even hamburger should never be put in their habitat - put these in an aquarium reserved for feeding.
• Give the crayfish plenty of hiding places because they are quite aggressive with each other and are likely to eat the smaller ones if they get the chance. Sometimes, if you have a crayfish or two that are much larger than the others, you might want to separate them so the smaller ones don't become dinner. Broken clay flower pots work great for hiding places.

**3. Designing the Crayfish Habitat**
Crayfish survive very well in an aquarium that is large enough for each of them to find a hiding place and not foul the water too quickly with their wastes. There should also be enough surface area of water so that an adequate supply of air in the water is available. The ideal classroom habitat is a small wading pool, filled to a level of about 3 - 4 inches and housing 10 or so animals. Smaller aquariums call for fewer crayfish, as a rule of thumb, figure about 5 crayfish for a 10 gallon aquarium. Fill the aquarium to 3-4 inches deep with dechlorinated water, add clean gravel to cover the bottom, add the broken flower pots or small whole ones for shelter and finally add 10 or so Elodea sprigs or other pond plants to provide oxygen to the water.

**4. Obtaining other supplies for the crayfish**
Elodea plants, dechlorinating liquid, feeder goldfish and live tubifex worms can all be purchased from a supply house like Carolina Biological, or they are usually easily and inexpensively obtained from your local aquarium store.

**5. Full or Partial Open-ended Inquiry?**
Decide if you plan to have your students do the complete investigation/full open-ended inquiry or if you will take them just up to that point and do the partial open-ended inquiry. If you decide on the latter, do the Alternate Session 3 at which point you will end the activity. The full open-ended inquiry takes five sessions to complete.

*Sidebar: Five sessions! We know that sounds like a lot, but this is a wonderful opportunity to immerse your students in a full open-ended inquiry as called for in the National Standards. This investigation will be something your students will always remember. Most importantly they are learning how to ask their OWN questions and figure out how they too can be scientists and figure out the answers. This activity is written with the goal of taking **all** your students through the process of thinking like a scientist, increasing their knowledge of how science works, and at the same time increasing their literacy skills. We hope you will give the full open-ended inquiry a try.*

**3. Making the Inquiry Journal**
Decide if you will have the students make their own Inquiry Journals from your directions or if you will duplicate the Inquiry Journal for each student from the attached pages (Pages 27-43). If students make their own journals, you can have them purchase a spiral notebook or other journal of your choice or simply have them staple 17 pages together and copy the questions onto the journal pages as you direct.

**4. Materials for the Investigation**
Session 3 asks students to make a list of materials they will need for their investigation the next day. It is hard to second guess what they might need, but there are some likely materials you will probably want to have on hand. (See What You Need list for Session 3.) Encourage your students to bring in most all of the materials they will need from home. Students will be doing their investigation in groups of 4-5 so they can share the task of gathering materials. Sometimes it is helpful to send a letter home to the parents alerting them that on a particular day, they should ask their student for their materials list (that way they don't need to start looking for materials late in the evening.)

**5. Crayfish Information Cards**
Duplicate two or more copies of the Crayfish Information Cards (starting on page 45) and cut apart the pieces of information. (Optional: laminate the pages before cutting them apart if you plan on reusing them.)

**6. Rules for What We Can Investigate**
Copy the Rules for What We Can Investigate (page 25) on chart paper or make into a transparency.

**7. Other Resources**
Gather books, posters and videos about crayfish, and other crustaceans and arthropods. Get on the internet and copy some of the web pages with interesting information. Visit the school and local library to find appropriate age related books with information your students can access. Ask your local colleges and high schools for any books they can loan

you. See the MARE On-line Resources for titles and ordering information.

8. Write out the Key Concepts in large, bold letters on chart paper.

> ***Crayfish have many adaptations to survive and thrive in a wetland habitat.***
>
> ***Scientists learn about the world through an inquiry process.***
>
> ***Inquiry science consists of making observations about the world, asking questions about the observations, doing investigations to discover answers to questions and making new observations leading to new explanations and questions.***
>
> ***Scientists communicate about their own and their peers' investigations and explanations.***

(Into the Activity)

## *Session 1: Crayfish Discoveries*

**Prologue**

1. Tell students they will have the opportunity to observe a living organism called a crayfish. Ask the students if any of them have ever caught or seen a crayfish before? Are they difficult to catch? How did they catch them? What else do they remember about crayfish? Tell the students that crayfish are very cool animals and they will have the chance to ask lots of very special questions about crayfish. The questions are special because if we observe the crayfish very carefully, the crayfish itself will answer some of the questions for us. We just need to be sure to ask the kind of question that the crayfish can answer through their actions. Another word for questions is **Inquiry**. We are going to use the word inquiry to mean scientific questions we can figure out the answers to by doing an **investigation** right here in the classroom.

2. Now tell the students that if we want these animals to do something besides just crouch in a corner and be frightened of the giants (us), how should we treat them? Elicit responses stressing how to show respect to the crayfish.

3. Share with them that you will know they are showing respect if you see them using all their senses to observe the

crayfish, except their sense of Taste (for obvious reasons), but also they shouldn't use their sense of Touch.....yet. Ask, why not use Touch? Elicit answers from the student, but here are three good ones:

1) It is difficult to watch the behavior of an organism if it is constantly being picked up and analyzed!
2) Students need to earn the right to hold this incredible creature by showing the teacher that they can treat it and their fellow scientists with respect.
3) Do not pick up the crayfish yet, because they are very likely to get pinched.

**Be sure to tell them that if they follow the rules, they will definitely be allowed to hold the crayfish just a little later.**

**The Crayfish Inquiry Journal**

In this activity, students make an inquiry journal which directs them through the inquiry process as it helps them to organize their notes and observations. The journal also gives the teacher the opportunity to assess the students' understanding throughout the investigation, models journaling with the students as a written dialog between students and teacher, and gives students the opportunity to build their literacy skills in another discipline.

1. Remind students how important it is for scientists to keep good notes and sketches so that they can refer to them later. Tell them they are going to make an inquiry journal to keep their notes and observations about the crayfish. The journal consists of 18 pages of paper stapled together, (or have students use a bound notebook.) Have students number and label the pages in their journal as shown on the model (pages 1-17) or duplicate the student pages for each student.

*If you would prefer, each page of the inquiry journal can be distributed to the students as you reach that part in the inquiry experience.*

**I Notice.....I Wonder (Inquiry Journal page 2)**

1. Have students work in a small cooperative group of four to five students. Distribute a pencil to each student and direct their attention to the first two pages of their Inquiry Journal (or distribute pages 1 and 2 to each student.)

2. Tell them in a hushed, whispery voice that you are just about to distribute an aquarium containing water and a crayfish to each table. Remind them that they look like a giant to the crayfish and you will be able to tell by the actions of the crayfish whether or not it is feeling safe or scared. We want the crayfish to feel safe, so the students need to keep their heads down low, with their eyes just peeking over the top of the aquarium; and no pounding on the table.

3. Tell the students that you will use a signal whenever you want to get their attention. You will say "Crayfish Eyes!" and everyone must immediately stop what they are doing and put their two index fingers on top of their head, just above their ears, as if they were eyes on stalks. Say, "Lets try it." "Crayfish Eyes!"

4. Tell the students that as soon as they get their aquarium, they are to make observations and communicate those observations in their Inquiry Journal on page 2. Have everyone turn to page 2 and direct them to list their observations in the I Notice column and their questions in the I Wonder column. Remind them to use all their senses except taste and touch.

5. Distribute the aquariums and crayfish to each small group. Walk around the room encouraging students to make observations and ask questions about what they observe.

6. After about 10 minutes, get the classes' attention with "Crayfish Eyes" and have students share what they observed as you record on the class I Notice chart. As you list their observations, ask questions such as whether or not everyone observed this, let's look again, does anyone disagree or have a different observation about it?

*Each group may give a different answer about how many legs the crayfish have. Some might count the pincers, some might not and some may count all the abdominal legs and others won't. In addition, some may have lost a leg during capture or confinement; if so, it will eventually grow back after several molts.*

**Mind Photographs (Even More Observations)**

1. Have the students take a picture in their mind of their crayfish by looking at the crayfish and then closing their eyes and picturing what it looks like. Have them do this two more times so that they have a very clear picture of their crayfish in their mind.

2. Have each group rotate to another crayfish and compare that crayfish with their own by closing their eyes again and visualizing their original crayfish.

3. Have each group say one way the crayfish are different from one another and one way they are alike. Make a large t-chart on the board with one side labeled All CRAYFISH HAVE and the other side labeled ONLY SOME CRAYFISH HAVE.

4. Now have the students work together and agree on and arrange the trays of crayfish in a sequence from largest to smallest. They might also sequence or categorize them based on color, markings, or size of pincers.

5. Ask the students if there are more observations we could now add to the class I Notice chart.

**Sketching the Crayfish (Inquiry Journal page 3 and 4)**

1. Now have the students turn to page 3 of the Inquiry Journal and have one of the students read the directions aloud to their small group. Have the students sketch their crayfish and add more observations and questions to I Notice/I Wonder.

2. After about 10 more minutes, tell the students that now that they have shown they respect the crayfish and are making great observations and sketches, have them turn to page 4 of the Inquiry Journal. Tell them that you will walk around to each group and show them how to carefully touch and pick up the crayfish to look at its underside. They will now be able to use their sense of touch so that they can draw the crayfish from this perspective. No one has to touch it or pick it up and no one is allowed to scare a classmate with the crayfish. This shows disrespect to everyone.

*If you have the crayfish in a transparent aquarium, one student can hold up the aquarium, while others look at the underside of the crayfish through the container.*

3. Show the students how to pick up the crayfish by squeezing its back with your thumb and forefinger, just behind their pinchers, with a firm, yet gentle grasp. Teach the students this technique and tell them that if they hold the crayfish like this, it cannot pinch them. It is as if someone were touching you in the middle of your back, just out of your reach. Model this on a student by touching them in the middle of their back and daring them to reach your finger.

4. Have the students again observe and sketch their crayfish as you walk around and pick up each of their animals in turn.

5. Remind the students to add new observations and questions about the underside of the crayfish to their I Notice I Wonder journal page.

6. After about 10 minutes, again get the students attention with "Crayfish Eyes!" and have them share their new discoveries with the class as you add their observations to the class I Notice Chart.

7. Collect the crayfish and return them to their larger aquarium habitat.

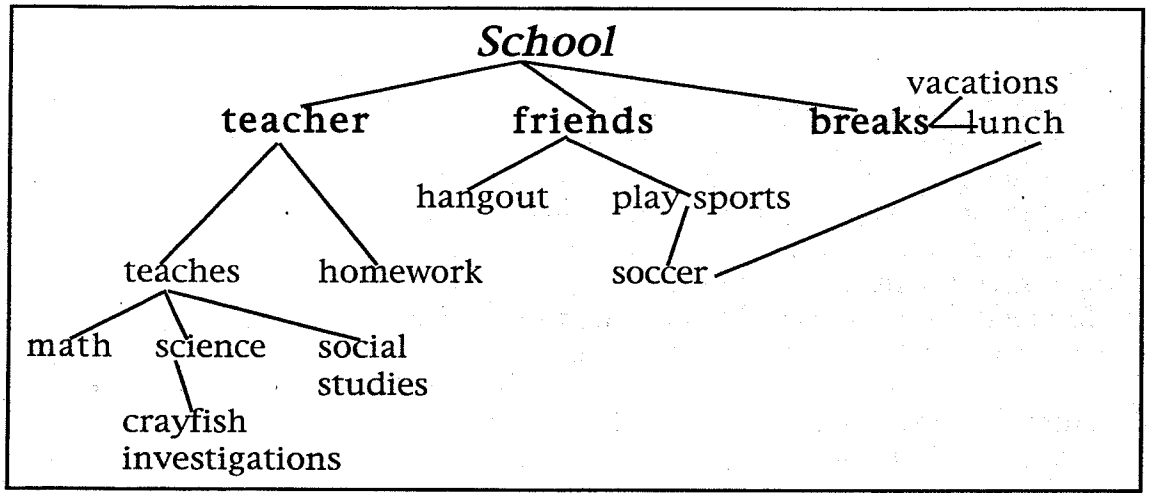
**Mind Maps**

1. Have students continue to work in their small cooperative group of four or five students. Tell them that each small group will make a mind or concept map showing what they already know about crayfish. Maybe they know a lot or maybe just a very little - it doesn't matter. What matters is that they show what they know and what kinds of connections they can make about their knowledge.

2. Tell the students that a mind map is a way of organizing what they know. One way to start a mind map is to make a list of words about everything you know about a subject. The next step is to group the words that have something in common and give the category a name, finally, use lines to show the connections between the categories and words.

3. Have the students help you make a mind map about something they already know a lot about, like toys or school so that they have an example. See the box below for an example mind map.

*You will probably want to spend more or less time on modeling how to make mind maps depending on the experience of your students.*




4. Now have them work in their small group to make a mind map of what they know about crayfish. Have them draw their mind map on the cover of their Inquiry Journal and then duplicate it on a transparency so that it can be shared with the class.

5. Share some (or all) of the transparencies on the overhead projector. Tell the class that this is great, but they will probably be incredibly amazed at how much more they will discover about crayfish in the next session.

*In the next session, the students will help you to generate categories for the questions about crayfish that they write. You may find it very helpful to look back at the concept maps and categories the students generated during this mind map activity.*

*(Through the Activity)*

## *Session 2: "I Wonder" - Generating the Questions*

1. Have students share and discuss their I Wonder lists with their small group. Distribute sentence strips and colored markers to each group and have them write their questions on the strips. Tell them to write only one question per strip, and not use a question more than once, even if more than one student in the group listed the question on their I Wonder list.

2. As groups finish writing their questions, have them tape the sentence strips up on the wall. Once every group has finished displaying their questions, read them aloud and ask the class to help you put them in categories. Ask the students what some of the categories might be. Discuss and write their categories on the board. (Some possible categories that students might suggest include: functions of different body parts, locomotion or movement, crayfish

senses, feeding and food preference, habitat preference, defenses, life cycle.) Suggest other categories depending on the observations of your students.

3. Add some of your "own" questions if students don't include the following:
- who is the crayfish related to?
- where does it live?
- how does it grow?
- does it have gills?
- how long can it stay out of water?
- does it live in fresh or saltwater?
- how do you tell the males from the females?
- how do you care for them in the classroom?
- why does it have so many different kinds of legs?

4. Write the name of the categories on sentence strips and tape them up around the room. Ask the students to help move each of the sentence strips under the appropriate category heading.

**Class Rules for Investigations (Inquiry Journal Page 5)**
1. Tell the students that they may be interested in choosing one of the questions on the wall for their crayfish investigation. But before they can decide which question they would like to investigate, the class needs to decide on rules about what they **can** investigate. (This process is also called determining the Criteria for Investigations.)

2. Have small groups of students discuss what they think would be good rules about what the class should be allowed to investigate. After a few minutes, lead a whole group discussion and record their rules on a class chart.

3. Circle those rules that everyone (including you) can agree on. Display the following rules as your contributions. Put a star by any of these rules that your students also suggested. Be sure to explain why each of them are of importance for **this** investigation. As you go through each of the rules, have the students help you find examples on the sentence strips that fit and don't fit the rules. (See Sidebar)

**Class Rules About What We Can Investigate**

1. Animals are not harmed in any way.
2. The question isn't too big - it can be answered by just one investigation and within one class period.
3. The materials needed are easy to get, inexpensive or already available in the classroom
4. The investigation is a what-happens-if, comparison or measuring question, not a why or how.
5. The question is interesting to the investigator
6. The question is important (or relevant) to the crayfish in its real life.
7. The question isn't a "Lookup" question.
8. The question can be answered by something you can **do** in **this** classroom.

*Sidebar: You will probably want to spend a little more time on explaining why it is that "what-happens-if," "comparison" and "measuring" questions are usually investigable and the "why" and "how" questions are not. Usually the why and how questions are too big of a question to be investigated in the classroom, but it doesn't make them any less important. In fact it has been the "wondering why" questions that have driven scientists to make discoveries.*

4. Tell students that if a question or investigation fits within the Class Rules then it is considered to be investigable. Those questions which do not fit the class rules are not investigable. Some questions that are not investigable for this classroom would certainly be investigable in other settings with more time and equipment. Have the students write down the Rules on page 5 of their Inquiry Journal.

**Choosing an Investigable Question**

Your students will generate many questions - some of which are appropriate for a classroom investigation and some which definitely are not! The former questions are called investigable and the latter not investigable questions. Not investigable questions may be great questions, but they are those which don't fit your Class Rules or criteria for investigation. The next step in the inquiry process is to determine which of the student generated questions are investigable and which are not. The students will then attempt to transform some of the not investigable into ones which they can investigate (investigable questions).

1. Tell students that they will travel around the room with a partner (or as a trio) and together pick two questions from the wall according to the following criteria:
• one question must be a lookup question

• one question must be not investigable according to the class rules.

Remind students that not investigable questions can often be recognized because they ask how or why.

2. Tell the students to move their "Lookup" questions to the spot you choose on the wall under the category heading: LOOKUP QUESTIONS

These questions are typical questions your students may ask about crayfish and probably mirror many of those questions which you now have taped around your room.

- How many legs does it have?
- Does it blink its eyes?
- What does it like to eat?
- How does it eat ?
- Can you sneak up behind it?
- Is it a male or female?
- Is it pregnant?
- What do the babies look like?
- What kind of substrate does it like the best?
- What will it do if we put another crayfish in its aquarium?
- Do the parents take care of the babies?
- How long will they survive out of water?
- What happens when a live goldfish is added to the aquarium?
- What do they use all the different legs for?
- What does it do when you touch its head?
- Does it prefer daylight or darkness?
- How does it protect itself?
- Does it prefer land or water?
- How does it find food ?
- How hard can it pinch?
- How often does it molt?
- What do they use their antennas for?
- Do they prefer cold or warm water?
- Does it prefer shallow or deep water?
- Can crayfish swim?
- Do crayfish move faster going forwards or backwards?

3. Have them take their not investigable question to their table and try to turn it into an investigable question that fits the Class Rules. Remind students that if they can change their not investigable question into one that asks the question what-happens-if, or if it measures or makes comparisons, then it is probably investigable.

4. After a few minutes have each of the student pairs or threesomes make a presentation to the class including the following: what was their not investigable question, why did they think it was not investigable and how they changed it to be an investigable question (if they were able to.) After their presentation, encourage students to discuss their ideas. Ask, what does the class think? Did they turn a not investigable question into one that is now investigable? Was the question impossible to turn into one that could be done in the classroom according to the investigation rules?

5. Return all the "new" investigable questions to the walls under the appropriate category heading. You might want to create a "parking lot" chart for any of the not investigable questions that remain.

**The Lookup Questions (Inquiry Journal Page 5)**
In this activity, students use resources to learn more about crayfish so they have information on which to base their own investigations.

1. Ask students how they could find out the answers to some of the lookup questions. Elicit responses and most likely someone will say "Look it up in a book!"

2. Tell them that some of these are very appropriate questions to look up. Point out any books you have around the room about crayfish (See Resources) and also distribute the Crayfish Information Cards randomly to each group. Tell them that they will find the answers to some of these questions in the written material you have given them.

3. Give students time to read and discuss their cards with their small group. Then have them switch cards with another group. Ask each group to share with the class one new word and one interesting thing they learned from the cards.

4. Lead a class discussion about which questions on the wall they can now answer based on their research or what they already know. Record the student answers to the questions on the board or chart paper and have students copy the information onto page 5 of the Inquiry Journal.

5. Optional: Have students observe the crayfish again to check out or verify their new information.

**Our Question to Investigate (Inquiry Journal Page 6 and 7)**

1. Tell students it is now time for them to pick the question they would like to investigate. If they pick a not investigable question, and are able to turn it into an investigable question, they will be allowed to investigate it.

2. Have students walk around the room looking at all the questions taped to the walls. Once they have decided on a question or category, have them stand in front of the category they chose.

3. After all the students have self-selected a category, have them discuss the posted questions with the other students who also selected that category. Have this group sit down together and decide which of the questions in that category they are most interested in investigating. Tell them their investigation group can be no larger than five or smaller than four students, so they may need to split into smaller investigation groups.

4. Have students turn to page 6 and write down the question they have chosen to investigate and then revise the question to make it more focused and if needed, to make it investigable. They are also asked to describe their hypothesis.

*Sidebar: Meaningful hypotheses come from having had some firsthand experience interacting with a situation. A hypothesis isn't just a guess, but rather it is based on some prior knowledge. For example, if you were told that a space ship was coming, you could only make a* ***guess*** *about what the aliens would look like. You couldn't actually make a* ***hypothesis*** *about it because you have no experience or prior knowledge on which to base it.*

5. On page 6 they are also asked to explain if their question fits the Class Rules About What They Can Investigate and then explain why.

6. Tell students that when they complete page 6, they can go onto page 7, which asks them to explain why their chosen question is interesting to them. The students also need to describe what relevance the question has to the real life of the crayfish; based on the information they learned from the Lookup Questions. Page 7 also asks the students to describe their feelings about the inquiry process thus far.

*If you don't plan to actually have students do the full open-ended investigation, then tell them that the class will do the investigation just* ***up to*** *the point of actually obtaining the materials. They don't need to actually bring them in.*

**Materials and Procedure (Inquiry Journal Page 8 and 9)**

1. This session ends with the students listing the materials they will need for their investigation, and who will get the materials. Encourage the students to bring needed materials from home if at all possible. Tell them they will be turning in their journal for you to review their investigation plan and materials and they need to be clear about what materials they will bring and what materials they need you to provide. **Emphasize to them that before they leave today, they must show you the materials list to make sure the requested items are all available.**

2. Tell the students that after their group has completed their materials list, the first few steps they plan to take, and sketched a diagram of their setup, they will describe their plan to another group and ask them for their opinions, ideas and advice. Have them take notes on the Advise from a Friend on the bottom of page 9.

3. Tell the students that you will also be giving them some advice on their investigation procedure, and will make your comments on page 10.

*Add a sidebar here to help guide teacher's comments and what they should be looking for in the students' procedures.*

4. Tell the students to be sure to bring in their materials because in the next session they will actually do their investigation and try to answer their question.

## *Alternate Session 3: If you do not have your students do the actual investigation.*

If you don't plan to have your students complete the investigation through Session 5, skip to the Mind Map on page 16 of the Inquiry Journal and follow the procedure for completing the Mind Map as described in Session 5, #5 and go ahead and share any more information you would like your students to know about crayfish. Finish up the activity with page 17 of the Inquiry Journal as described in the Wrap-up in Session 5.

## *Session 3: The Investigation*

1. Have students preview pages 11 - 12 in their Inquiry Journal so they know where to keep their notes and results of their investigation. Tell them that they need to describe what happened and what their results tell them about crayfish (their conclusion.)

2. Show students that they are also asked to write down more questions on page 12. Ask, why do they think there is such a big deal made of asking questions? Elicit their responses, and be sure to share with them that science is about asking questions and the sign of a good investigation is that it generates even more questions.

3. Encourage students to get started on their investigations right away. Tell them that they need to complete their investigation and pages 11-12 by the end of this period.

4. After students have competed pages 11 - 12, direct them to clean up their work space and return the crayfish to its habitat, but they should save some key part of their investigation setup to use as a visual aid for their upcoming presentation.

## *Session 4: Making Posters and Presenting the Results (Part 1)*

**Making the Presentation Poster (Inquiry Journal page 13)**
1. Tell students that they will have about 20 minutes to work on a poster to use for their group presentation. The information they need to include on their poster is listed on page 13. They will also use part of their investigation setup as a visual aid to describe their procedure and results.

2. Distribute chart paper and colored markers to each group. Remind them that they have about 15 - 20 minutes to complete their poster and practice their presentation. Each member of the investigation group should be prepared to present, so the group should decide how to split up the presentation so that everyone has a part to play. Remind them that they will present in pairs.

3. Have the students tape up their presentation posters, making sure to keep some distance between posters so the explainers at each poster are not competing for the students'

attention. Have them complete the first question on page 14.

**The Gallery Walk**

1. Describe to the students what the presentation procedure will be like. They will work with a partner and present their poster to two students at a time for a total of four times (If you have a class of 20 and there were five investigation groups.) They will then switch with the other members of their investigation team, and listen to the presentations from the other investigation groups. (See the box below for the detailed teacher directions for the Gallery Walk.)

### The Gallery Walk

1. Each group will tape their poster up on the wall to create a Gallery of Investigations.
2. Two members of each investigation group will stand in front of their poster and prepare to describe their investigation.
3. The rest of the class will disperse evenly around the room, as investigation pairs, taking up a position in front of one of the presentation posters (not their own.) (For a class of twenty, there will be ten presenters and 10 listeners.)
4. Every 3- 5 minutes, upon a signal from the teacher, students watching the presentations and asking questions of the presenters will rotate in a clockwise fashion to the next poster and listen to that presentation.
5. For example, If there were five investigation groups in the class, each pair of students from one investigation group will need to present their poster for a total of four times, at which point half of the students in the class would have heard their presentation.
6. The pairs will now switch, so that those presenting the poster will now be listening to other presentations in the Gallery Walk. After they present their poster four times, the entire class will have seen every presentation.

2. Start the Gallery Walk. Have students take their Inquiry Journal with them as they listen to presentations so that they can take notes on the bottom half of page 14. You will have time to complete one round of presentations so that the students presenting the posters this session will be listening to presentations during the next session.

*Sidebar: Some teachers have said that they would prefer to do group presentations rather than the Gallery Walk. It would save time, 25 minutes Vs 50 minutes, but teachers who have tried the Gallery Walk have told us that they feel that the extra time is well worth it. The kinds of questions and the sharing of information that occurs as students engage in real conversation with other student scientists has been incredible. This less formal presentation also helps all students, including English language learners to feel comfortable to offer their ideas and ask (and receive) hard questions of their peers.*

*(Beyond the Activity)*

## *Session 5: Synthesis or Putting it All Together (Inquiry Journal Page 14–17)*

1. Complete the second half of the Gallery Walk and remind the students to complete page 14.

2. After all the presentations are complete, lead a class debrief about everything the class learned about crayfish from all the investigations. Remind students to refer to their notes on the bottom of page 14. Record their ideas on chart paper and have them add any new information from the class to their own notes. Encourage them to take complete notes on what the class learned because they will need to refer to these notes later.

3. Give students time to complete page 15 and then lead a class debrief of all the questions they still want to find out about crayfish. Record their questions on the board or chart paper and have students add them to their own list on page 15.

4. Discuss the other questions listed on page 15, encouraging the students to offer their opinions and constructive criticisms.

5. Direct students to page 16 of the Inquiry Journal and have them do an individual mind map of everything they have learned about crayfish. Tell them they can use all the information in their Inquiry Journal. Have them draw their map on page 16. When they complete their individual mind maps, remind them to compare this synthesis mind map with the mind map they made at the beginning of the activity. Students will be amazed at how much they have discovered through their own investigations.

6. Have the whole class help you create a mind map on a transparency of what the whole class collectively knows about crayfish. Remind the students to look back at their own mind maps when commenting on the class map.

**Wrap-up**

1. Ask the students what they learned by using a live crayfish that they probably couldn't have learned if they had just used pictures or a model of a crayfish? What was their favorite part of the activity? What was their least favorite?

2. Tell them that their home activity will be to complete page 17 in their Inquiry Journal, which is to write about a Day in the Life of a Crayfish using everything they have learned about crayfish from their own inquiry as well as what they learned from their classmates investigations.

3. When they bring in their completed stories, ask for volunteers to read them aloud or have them share them in their small groups. You might want to create a scoring rubric for this literacy and concept synthesis activity or for the Inquiry Journal as a whole.

4. Hold up the key concepts and have students read them aloud. Post the concepts on the wall next to the students' posters.

> ***Crayfish have many adaptations to survive and thrive in a wetland habitat.***
>
> ***Scientists learn about the world through an inquiry process.***
>
> ***Inquiry science consists of making observations about the world, asking questions about the observations, doing investigations to discover answers to questions and making new observations leading to new explanations and questions.***
>
> ***Scientists communicate about their own and their peers' investigations and explanations.***

*You might also consider having the students write their own key concepts and post them on the wall based on what they discovered about crayfish in their individual investigations.*

# Going Further

## What's in a Name

Of course the crayfish is not a fish at all. In some areas they are called crawfish or crawdads. Have the students participate in a contest to give the crayfish a more appropriate name. The students can make posters and slogans in support of their choice and then vote on the winning name. You might want to extend this to include new names for other wetland creatures such as oysters, clams, and mussels.

## Field Trip

Take a field trip to a pond or marsh to observe crayfish in their natural habitat. Use a baited minnow trap to capture some crayfish and compare them to the ones you had in your classroom. Remember there are over 500 species of crayfish! You can also take a field trip to a seafood market to observe many different species of crustaceans.

## Live Animal Comparison or Photo Comparison

Bring live shrimp, crabs, or lobsters into the classroom or use photos or drawings of different crustaceans. Distribute a different crustacean (or drawing) to each small group. If you have brought in live animals, have the students observe the behavior and compare to the crayfish. Have each group make a detailed, labeled drawing of their animal and then make a presentation to the class. As the students make their presentations, list the attributes on a large T-Chart (sample below) with one side labeled ALL CRUSTACEANS HAVE and the other side labeled ONLY SOME CRUSTACEANS HAVE.

| ALL CRUSTACEANS HAVE | ONLY SOME CRUSTACEANS HAVE |
|---|---|
| legs | antennae |
| shell (exoskeleton) | bright colors |
| mouth | long tail |
| | pincers |

## Library Research

Visit the library and learn about the freshwater habitat of the crayfish. Learn who its enemies are and about other animals living with the crayfish. Have the students draw a picture of the crayfish in its natural habitat.

## Science Fair Projects

Use the students' investigations as their science fair project. Look at the guidelines for how your school or district wants the information presented and spend some time in class

creating the displays or send the instructions home for the parents to make the actual display.

## Scientist in the Classroom

Invite a scientist into your classroom and have him/her share something about their research. Parents, museums and universities are often good places to find people willing to come in and talk to your students. Perhaps they can even bring in some of their research equipment. Have students prepare for their visit by doing some preliminary research on the scientist's field of study and listing some questions they would like the scientist to answer.

Some possible questions to ask:

- What question is the scientist investigating?
- How did s/he decide on the question?
- How did s/he know that nobody else had already answered the question?
- Why is the question interesting to them and how is it relevant to the real world?
- What is their hypothesis?
- What did s/he have to do in school to prepare to become a scientist?
- Does s/he like their work?

# Class Rules About What We Can Investigate

1. Animals are not harmed in any way.

2. The question isn't too big - it can be answered by just one investigation and within one class period.

3. The materials needed are easy to get, inexpensive or already available in the classroom.

4. The investigation is a what-happens-if, comparison or measuring question, not a why or how.

5. The question is interesting to the investigator.

6. The question is important (or relevant) to the crayfish in its real life.

7. The question isn't a "Lookup" question.

8. The question can be answered by something you can **do** in **this** classroom.

# *Crayfish Investigations Home Activities*

SCIENCE FAIR PROJECT
Enter your crayfish investigation into the science fair at your school or district. Ask your family to help you make the poster you will need to display your work.

SCIENTISTS IN YOUR NEIGHBORHOOD
Do you have any family, friends or neighbors who are research scientists? Call them up and ask them about their research and how they decided on their investigation question. Be sure to tell them about your investigation.

COLLECT MATERIALS FOR YOUR INVESTIGATION
Ask your family to help you gather the materials you will need to do your classroom crayfish investigation. Tell your family what you plan to do for your investigation and why it is interesting to you. Ask them what they think will happen and why.

FAMILY OUTINGS
• Ask your parents to take you to a seafood market or the seafood section of your local grocery store. Look at all the kinds of crustaceans they have. Do they keep any of them alive? Before you go, list some questions about obtaining, keeping and selling crustaceans that you would like to ask the seafood manager. Sketch all the crustaceans you see. What do they all have in common and how do they differ from one another? Did you see anyone buying crustaceans? Ask them how they plan to cook them.

• Ask your family to visit a local creek, lake, pond, or wetland to look for crayfish. Encourage your family to help you watch the behavior of the living crayfish and write down any questions you or your family has about what you see. Can you answer some of their questions? Teach them what you know about crayfish adaptations and behavior. Try to catch some of the crayfish to look at them more closely. How do they differ from the crayfish you investigated in class? Write down your observations and make a detailed, labeled sketch of the crayfish in its habitat.

MORE INVESTIGATIONS
If you find and catch any crayfish in your local streams, you may be able to answer some of the questions asked in your class that were not investigable because they took longer than 1 day to complete. Maybe you could design an investigation to answer one or more of the following questions (or use one of your own): will they mate in captivity? Do the parents take care of their young? How fast do they grow in captivity? How often do they molt in captivity? Remember the most important Class Rule was that the animal won't be harmed in any way. Be sure to treat it with respect and care and return it to its habitat after your investigation.

Page 1

# My Crayfish Inquiry Journal

by _____

Page 2

| I Notice | I Wonder |
| --- | --- |
| | |

Page 3

Draw your crayfish here and draw it **big**! Label the parts you see with a word that describes how it looks or what it does. As you are drawing, go back and add more observations and questions to I Notice/ I Wonder.

**Page 4**

**Draw the underside of the crayfish here and draw it big! label the parts you see with a word that describes how it looks or what it does. As you are drawing, go back and add more observations and questions to I Notice/ I Wonder.**

Page 5

## Our Class Rules About What We Can Investigate

## The LOOKUP QUESTIONS: What we found out about crayfish by looking up the answers

**Page 6**

**Here is the question about crayfish that we would like to investigate:**

**Here is how we revised the question so that we can investigate it:**

**My hypothesis is:**

**Does My Question Fit Our Class Rules About What We Can Investigate? Write yes or no for each of the rules and why you think it fits or doesn't fit the class rules**

## Page 7

**This question is interesting to me because**

**I think my question is important in the real world of the crayfish because**

Page 8

# Our Plan

| Materials We Need | Are the materials already available in the room? If not, who is responsible for gathering and bringing the materials? |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

Here are the first few steps we plan to take:

page 9

Here's a picture of the investigation setup:

Here's the advice we got from a friend about OUR PLAN (and how we plan to modify our plan based on their advice.)

## Page 10

**Here's the advice we got from our Teacher about OUR QUESTION and PLAN**

Page 11

Here's what happened when I tried my investigation
*(These are My Results)*

Were the results the same as your hypothesis or were they different from your hypothesis? _____

Give at least one example of how the results were the same or different from your hypothesis.

This is what my results tell me about crayfish and here are some ideas I have about how to explain my results:
*(This is Your Conclusion)*

Page 12

Now I have even more Questions about crayfish ....here are some of my new questions:

Here are some ideas I have about how we could figure out the answers to one or two of our new questions:

Page 13

## Our Presentation Poster

1. Our Question:

2. Hypothesis:

3. A drawing of our investigation setup

4. Our results in words and pictures:

5. Our Conclusion (What the results tell us about crayfish):

6. New Questions we now have about crayfish

Page 14

Here are some of the questions I think my classmates will ask me during my presentation:

This is how I felt after I made my presentation:

What I Learned From Other Groups' Presentations About Crayfish:

Page 15

Here are some questions about crayfish that I still wonder about:

I Liked the Crayfish Inquiry Because:

I Didn't Like the Crayfish Inquiry Because:
(and here is how I would change it...)

## Page 16
## My Mind Map About Crayfish

Page 17

**Write About A Day in the Life of a Crayfish. Use all the information you learned about crayfish from your own inquiry and your classmates' investigations. (Remember to use descriptive language.)**

## Crayfish Information Cards

Crayfish are **invertebrates**. Invertebrates are animals without backbones. Worms, jellyfish, anemones, crabs, insects and many other animals are invertebrates. People and other mammals, reptiles, amphibians, fish and birds are all **vertebrates** and have a backbone.

Crayfish have many senses to learn about their habitat. They find food, a mate, a hiding spot, and escape predators by using their senses. Crayfish have two pairs of **antenna** that help them to sense their habitat. One pair is very long and one pair is short. The shorter ones are called **antennules** and each is split into two so it looks almost like they have four short antennules. On the base of the antennules is an organ called a **statocyst**. The statocyst helps the crayfish to know which side is up and which side is down.

Crayfish have a long pair of **antenna** that they use to help them sense their habitat. They use them for their sense of touch to help them find their food when it is nearby. They can also use their antenna to taste or smell the water to find food that is farther away. At the base of the antennas there is an organ called the **green gland**. This is where the urine (pee) comes out.

Crayfish have eyes on stalks that helps them to see a very wide area around them at one time. They can probably tell the shape and size of objects and some color, but can't really see an image like we do. They are very good at seeing any movement around them though and will react very quickly.

Crayfish and their very close relatives like crabs, lobsters and shrimp are a special group of animals called **Crustaceans**. Think of crustaceans as being the crusty, crunchy animals. This name refers to the hard exoskeleton that covers just about their entire body. Crustaceans and other arthropods wear their skeleton on the outside of their body instead of on the inside like people do.

One of the most successful groups of animals in the world are the animals in the group called **Arthropoda**. The word Arthropoda means "jointed legs." It makes sense that a jointed-leg animal might be called an Arthropod because that word sounds kind of like the word arthritis - the disease where your joints hurt. There are three times more kinds of arthropods than all other kinds of animals in the world combined.

Arthropods include insects, spiders, mites, and crustaceans such as the crayfish, lobster, crab, barnacle, and shrimp. These animals all have an **exoskeleton**, which means they wear something like a skeleton on the *outside* of their body. The exoskeleton gives strength and support to their body and also gives their muscles a sturdy place to attach. It does something more too. The hard exoskeleton protects the arthropods soft inner body from many predators or other dangerous things in the habitat.

Almost all crustaceans live in salt water. Crayfish are one of the exceptions. They live in freshwater or some kinds even live in water that is called **brackish**. Brackish water is kind-of salty and kind-of fresh. It is the kind of water found in wetland estuaries --where the freshwater flowing in from a river mixes with saltwater coming in from the ocean.

There are more than 500 species or kinds of crayfish and they are found throughout the world, but only in freshwater or brackish water (a mixture of salty and fresh). They live in swamps, marshes, wetlands, ponds, streams, and even cold lakes and fast-running rivers. They are found in all coastal areas of the United States, including Hawaii, and have been introduced in Costa Rica, Spain, France, Africa and Japan.

All arthropods, which include crustaceans, are covered with a hard external skeleton (exoskeleton) that is jointed so they can move. It kind of like they are wearing a suit of armor. This exoskeleton does become a problem when the inner body grows. An exoskeleton doesn't grow or even stretch, so they must shed or **molt** it so the body can grow larger.

By the time a crustacean molts or sheds its exoskeleton so it can grow, a new, soft exoskeleton has already started to form underneath the old one. But before its new exoskeleton hardens around its soft body, the animal swells up with water to an even larger size. Then after the exoskeleton hardens, the animal can get rid of all this excess water. By swelling up, the crayfish has made sure that it has some room to grow before it has to molt again.

All crustaceans, including crayfish have gills covered by a **carapace**. This is the shield-like part of the exoskeleton that covers the head and most of the back. The carapace also wraps around the sides of the body above the walking legs. In shrimp, lobsters, and crayfish, the tail section, or abdomen, extends back past the carapace and ends in the **telson** or fan-like tail.

Crustaceans can spend some time out of water, but must always keep their **gills** wet so they can breathe. Most crayfish can remain out of water for only about 10 minutes at a time. The gills of crayfish are located under the carapace and just above the walking legs.

Crayfish, crabs, and lobsters are called **decapod** crustaceans because they have ten large legs. The first pair of legs are pincers. Pinchers are used to defend against predators, to help in competition with other crayfish, and to catch and tear food into smaller pieces. A crayfish can definitely pinch hard enough to really hurt, so keep your fingers out of its reach!

The mouth parts of decapods are legs which have been greatly changed. They are used kind-of like fingers and teeth to sort and move food around after the pincers bring it to the mouth. The mouth parts are not counted as part of the ten legs of decapods.

Crayfish have four pairs of legs that are used mostly for walking, but also for handling food and cleaning itself. These walking legs have small pinchers that they use to grasp onto things. The legs have many small hair-like structures that they use to sense the habitat around them. They can tell that they are touching something if those hairs are moved.

In female crayfish, the legs on the abdomen or tail section are used to hold the eggs until they hatch. They also are used as fans to make sure the eggs have lots of oxygen. These abdominal legs are called **swimmeretts** because they help the crayfish to swim. They are weak swimmers though and can't float. In male crayfish the first swimmerette points towards the head and is usually white-tipped. In females, all the swimmerettes look very much the same.

The crayfish uses its strong tail to dart backwards rapidly by bending it towards the belly with lightening speed. This allows them to escape predators and to right themselves when they end up on their back. In crabs, the tail and abdomen are very small and are wrapped tightly underneath the body. Female crabs have a wide rounded abdomen used as a shelf to hold their eggs. Male crabs have a narrow abdomen shaped like a triangle.

Crayfish can be very aggressive towards one another. It is important that each crayfish be given a place to hide. Crayfish will eat almost any kind of fresh or frozen fish and can actually live for over a month without being fed. They will also eat live food such as goldfish and water plants. Because these animals eat food, they must poop out the wastes. The place the poop comes out can be found at the tip of the abdomen, just before the fan-like tail.

Crayfish have pincers like crabs and walking legs like shrimp. Also, like crabs, they can hang onto rocks and water plants so they aren't dragged away with strong water movement. Although they live only in fresh or nearly fresh water, crayfish have a lot in common with their saltwater relatives, but are easier to get and keep alive in the classroom. By observing crayfish that live in streams and ponds, we can begin to understand how their ocean relatives live as well.

## Background

One of the most successful groups of animals in the world are the members of the phylum Arthropoda, which means "jointed legs." There are three times more species of arthropods than all other animal species combined. This group of invertebrates (animals without backbones) includes the insects, spiders, mites, and the crustaceans such as the crayfish, lobster, crab, barnacle, and shrimp. The crustaceans are almost entirely marine (living in salt water) and many live at the rocky seashore. One of the freshwater exceptions is the incredibly successful crayfish.

There are more than 500 species of crayfish and they are found throughout the world in swamps, marshes, ponds, streams, and even cold lakes and fast-running rivers. They are found in all coastal areas of the United States, including Hawaii, and have been introduced in Costa Rica, Spain, France, Africa and Japan.

All arthropods, which include crustaceans, have several features in common. They are all covered with a hard external skeleton (exoskeleton) that is segmented so they can move. Arthropods must shed or molt the exoskeleton in order to grow because it cannot grow as the inner body does. By the time a crustacean molts, a new, soft exoskeleton has already started to form underneath the old one. As soon as it molts, the animal inflates its new exoskeleton to a larger size by swelling itself with water. This allows for some growing room before the next molt is necessary.

Crustaceans are very successful living between the rise and fall of the tides in the wetlands and these same adaptations allow crayfish to live in very diverse freshwater systems. All crustaceans have gills covered by a carapace—the shield-like part of the exoskeleton that covers the head and most of the back, and wraps around the sides of the body above the walking legs. In shrimp, lobsters, and crayfish, the tail section, or abdomen, extends back past the carapace and ends in the telson or fanlike tail. Crustaceans can stay out of water for varying lengths of time, but must always keep their gills moist so they can breathe. Most crayfish can remain out of water for only about 10 minutes at a time.

Crayfish, crabs, and lobsters are called decapod crustaceans because they have ten large legs. The first pair of legs is modified into pincers, which are used to defend against predators, help in competition with other crustaceans, and catch and tear food into smaller pieces. Actually, even the mouth parts of decapods are modified

legs (not counted among its ten) and are used to sort and manipulate food after the pincers bring it to the mouth.

The next four pairs of legs are used primarily for walking, but also for handling food and cleaning itself. In crayfish, the legs on the abdomen or tail section are used in reproduction to hold masses of dark, spherical eggs until they hatch. They are also used as fans to keep the eggs oxygenated. These abdominal legs are called swimmerets because they help the crayfish to swim, although they are weak swimmers and cannot float. The crayfish uses its strong tail to dart backwards rapidly by flexing it towards the belly. This allows them to escape predators and to right themselves when they end up on their back. In crabs, the tail and abdomen are very much reduced and are wrapped tightly underneath the carapace. Female crabs have a wide rounded abdomen used as a shelf to hold their eggs. Males have a narrow, triangular abdomen.

Crayfish can be very aggressive towards one another. It is important, if you are keeping them for any length of time, that each crayfish be given a place to hide. Crayfish will eat almost any kind of fresh or frozen fish and can actually live for over a month without being fed. They will also eat live food such as goldfish and water plants.

Crayfish have to contend with fast moving rivers, whereas its seashore relatives, crabs and shrimp, have the changing tides and crashing waves to deal with. Crayfish have pincers like crabs and walking legs like shrimp. Also, like crabs, they can hang onto rocks and water plants so it isn't dislodged with strong water movement. By observing crayfish that live in streams and ponds, we can begin to understand how their ocean relatives live as well.